



US008551039B2

(12) **United States Patent**
Veit et al.

(10) **Patent No.:** **US 8,551,039 B2**
(45) **Date of Patent:** ***Oct. 8, 2013**

(54) **DRUG DELIVERY WITH EVENT NOTIFICATION**

(75) Inventors: **Eric D Veit**, Pleasanton, CA (US);
Adam Bylund, Jacksonville, OR (US);
Barry Weber, Livermore, CA (US);
Peter Luther, Pleasanton, CA (US);
Joseph McCluskey, Sharon, MA (US);
Jean Bidegainberry, San Francisco, CA (US)

(73) Assignee: **LifeScan, Inc.**

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 12 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **13/076,420**

(22) Filed: **Mar. 30, 2011**

(65) **Prior Publication Data**

US 2011/0184343 A1 Jul. 28, 2011

Related U.S. Application Data

(60) Division of application No. 12/723,505, filed on Mar. 12, 2010, which is a continuation of application No. 10/981,830, filed on Nov. 5, 2004, now Pat. No. 7,713,229.

(60) Provisional application No. 60/518,571, filed on Nov. 6, 2003.

(51) **Int. Cl.**

A61M 31/00 (2006.01)

A61B 5/00 (2006.01)

(52) **U.S. Cl.**

USPC **604/67**; 604/65; 604/66; 600/316

(58) **Field of Classification Search**

USPC 604/500, 65, 66, 67, 187; 600/316, 600/322, 309

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

3,837,339 A	9/1974	Aisenberg et al.
3,923,426 A	12/1975	Theeuwes
4,146,029 A	3/1979	Ellinwood, Jr.
4,270,532 A	6/1981	Franetzki et al.
4,282,872 A	8/1981	Franetzki et al.
4,360,019 A	11/1982	Portner et al.
4,373,527 A	2/1983	Fischell
4,395,259 A	7/1983	Prestele et al.
4,447,224 A	5/1984	DeCant et al.
4,475,901 A	10/1984	Kraegen et al.
4,494,950 A	1/1985	Fischell

(Continued)

FOREIGN PATENT DOCUMENTS

EP	0098592	1/1984
EP	0300552 A1	1/1989

(Continued)

OTHER PUBLICATIONS

Japanese office action dated May 18, 2010, application No. 2006-538489, Tokoyo, Japan, 3pages.

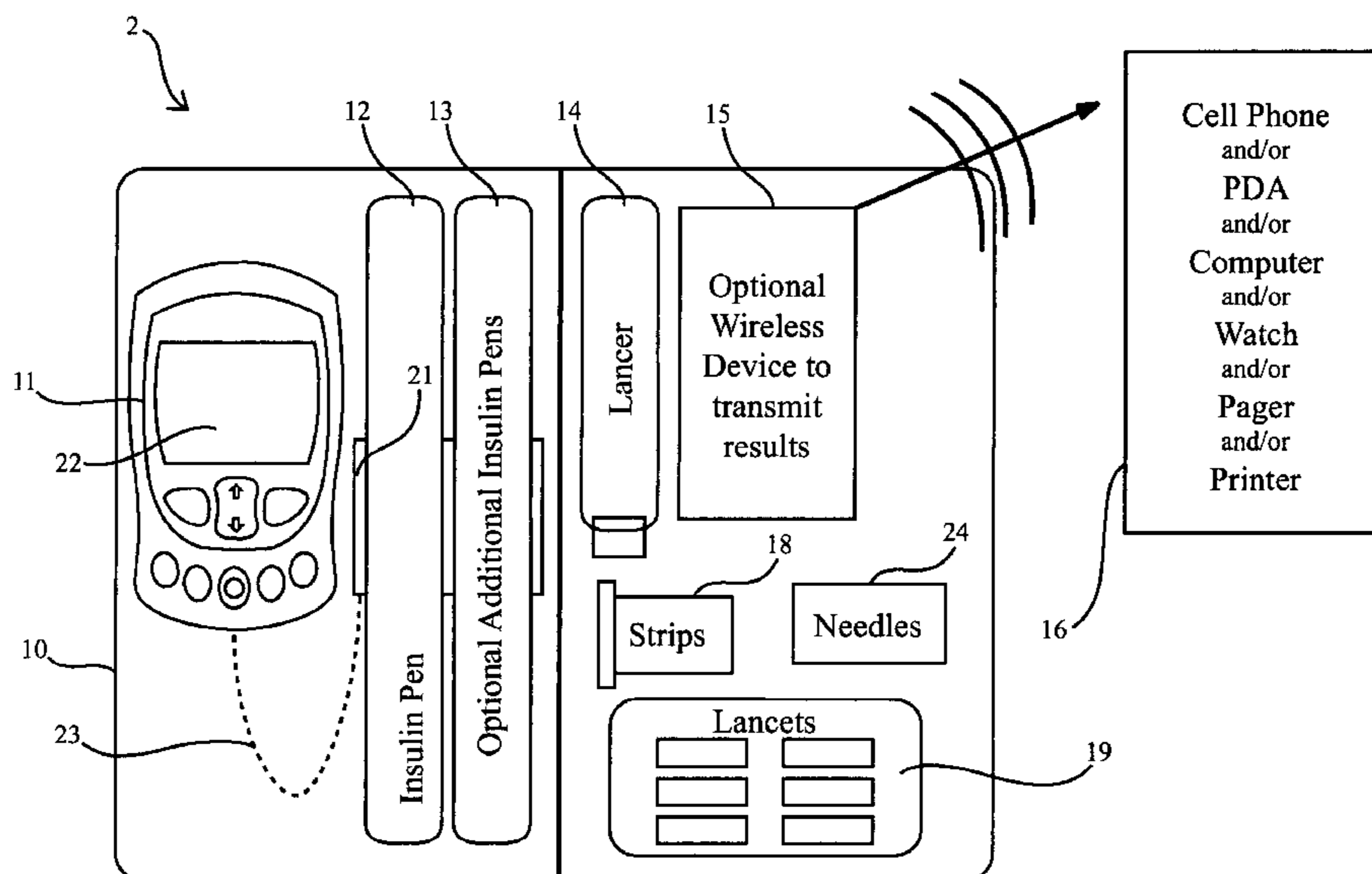
(Continued)

Primary Examiner — Victoria P Shumate

(57) **ABSTRACT**

Devices, systems and methods are provided for drug delivery and the monitoring thereof.

24 Claims, 4 Drawing Sheets



(56)

References Cited

U.S. PATENT DOCUMENTS

4,515,584 A	5/1985	Abe et al.	5,925,021 A	7/1999	Castellano et al.
4,529,401 A	7/1985	Leslie et al.	5,928,195 A	7/1999	Malamud et al.
4,559,037 A	12/1985	Franetzki et al.	5,935,099 A	8/1999	Peterson et al.
4,562,751 A	1/1986	Nason et al.	5,950,632 A	9/1999	Reber et al.
4,601,707 A	7/1986	Albisser et al.	5,951,836 A	9/1999	McAleer et al.
4,619,653 A	10/1986	Fischell	5,968,836 A	10/1999	Matzinger et al.
4,633,878 A	1/1987	Bombardieri	5,972,294 A	10/1999	Smith et al.
4,636,144 A	1/1987	Abe et al.	6,024,539 A	2/2000	Bloomquist
4,678,903 A	7/1987	Wlodarczyk et al.	6,024,699 A	2/2000	Surwit et al.
4,692,147 A	9/1987	Duggan	6,038,676 A	3/2000	Yanes et al.
4,714,462 A	12/1987	DiDomenico	6,134,504 A	10/2000	Douglas et al.
4,731,051 A	3/1988	Fischell	6,144,922 A	11/2000	Douglas et al.
4,731,726 A	3/1988	Allen	6,192,891 B1 *	2/2001	Gravel et al. 604/187
4,734,360 A	3/1988	Phillips	6,193,873 B1	2/2001	Ohara et al.
4,776,842 A	10/1988	Franetzki	6,238,338 B1	5/2001	DeLuca et al.
4,803,625 A	2/1989	Fu et al.	6,241,704 B1	6/2001	Peterson et al.
4,810,243 A	3/1989	Howson	6,241,862 B1	6/2001	McAleer et al.
4,826,810 A	5/1989	Akoi	6,248,093 B1	6/2001	Moberg
4,871,351 A	10/1989	Feingold	6,270,455 B1	8/2001	Brown
4,900,666 A	2/1990	Phillips	6,277,098 B1	8/2001	Klitmose et al.
4,935,346 A	6/1990	Phillips et al.	6,283,944 B1	9/2001	McMullen et al.
4,950,246 A	8/1990	Muller	6,284,125 B1	9/2001	Hodges et al.
4,985,015 A	1/1991	Oberman et al.	6,336,900 B1	1/2002	Alleckson et al.
4,995,402 A	2/1991	Smith et al.	6,378,702 B1	4/2002	Hintzig
5,019,974 A	5/1991	Beckers	6,406,605 B1	6/2002	Moles
5,059,394 A	10/1991	Phillips et al.	6,418,346 B1	7/2002	Nelson et al.
5,097,122 A	3/1992	Colman et al.	6,443,890 B1	9/2002	Schulze et al.
5,135,479 A	8/1992	Sibalis et al.	6,444,115 B1	9/2002	Hodges et al.
5,176,632 A	1/1993	Bernardi	6,475,372 B1	11/2002	Ohara et al.
5,204,670 A	4/1993	Stinton	6,482,185 B1	11/2002	Hartmann
5,216,597 A	6/1993	Beckers	6,524,239 B1	2/2003	Reed et al.
5,251,126 A	10/1993	Kahn et al.	6,529,446 B1	3/2003	de la Huerga
5,304,468 A	4/1994	Phillips et al.	6,540,672 B1	4/2003	Simonsen et al.
5,306,623 A	4/1994	Kiser et al.	6,554,798 B1	4/2003	Mann et al.
5,364,838 A	11/1994	Rubsamenn	6,585,698 B1	7/2003	Packman et al.
5,368,562 A	11/1994	Bloomquist et al.	6,595,956 B1	7/2003	Gross et al.
5,376,070 A	12/1994	Purvis et al.	6,641,533 B2 *	11/2003	Causey et al. 600/300
5,417,222 A	5/1995	Dempsey et al.	6,656,114 B1	12/2003	Poulsen et al.
5,418,142 A	5/1995	Kiser et al.	6,669,663 B1	12/2003	Thompson
5,426,032 A	6/1995	Phillips et al.	6,681,003 B2	1/2004	Linder et al.
5,433,736 A	7/1995	Nilsson	6,723,068 B2	4/2004	Lavi et al.
5,497,772 A	3/1996	Schulman et al.	6,733,655 B1	5/2004	Davies et al.
5,507,288 A	4/1996	Bocker et al.	6,781,522 B2	8/2004	Sleva et al.
5,515,170 A	5/1996	Matzinger et al.	6,790,178 B1	9/2004	Mault et al.
5,526,120 A	6/1996	Jina et al.	6,837,876 B2	1/2005	Bally et al.
5,536,249 A	7/1996	Castellano et al.	6,869,413 B2	3/2005	Langley et al.
5,544,651 A	8/1996	Wilk	6,939,324 B2	9/2005	Gonelli et al.
5,544,661 A	8/1996	Davis et al.	6,942,646 B2	9/2005	Langley et al.
5,558,638 A	9/1996	Evers et al.	6,951,631 B1	10/2005	Catt et al.
5,558,640 A	9/1996	Pfeiler et al.	7,109,878 B2 *	9/2006	Mann et al. 340/654
5,563,042 A	10/1996	Phillips et al.	7,133,329 B2	11/2006	Skyggebjerg et al.
5,569,186 A	10/1996	Lord et al.	7,220,244 B2	5/2007	Kriesel
5,569,187 A	10/1996	Kaiser	7,282,029 B1	10/2007	Poulsen et al.
5,593,390 A	1/1997	Castellano et al.	7,397,730 B2	7/2008	Skyggebjerg et al.
5,620,863 A	4/1997	Tomasco et al.	7,534,230 B2	5/2009	Follman et al.
5,658,250 A	8/1997	Bloomquist et al.	2002/0126036 A1 *	9/2002	Flaherty et al. 341/176
5,665,065 A	9/1997	Colman et al.	2003/0038047 A1	2/2003	Sleva et al.
5,678,562 A	10/1997	Sellers	2003/0058110 A1	3/2003	Rich
5,708,247 A	1/1998	McAleer et al.	2003/0099158 A1	5/2003	De la Huerga
5,728,074 A	3/1998	Castellano et al.	2003/0109827 A1	6/2003	Lavi et al.
5,735,887 A	4/1998	Barreras et al.	2003/0208113 A1	11/2003	Mault et al.
5,753,452 A	5/1998	Smith	2003/0220814 A1	11/2003	Gordon
5,764,159 A	6/1998	Neftel	2004/0023972 A1	2/2004	Sundermann et al.
5,773,452 A	6/1998	Sauerberg et al.	2004/0039255 A1	2/2004	Simonsen et al.
5,780,304 A	7/1998	Matzinger et al.	2004/0122355 A1	6/2004	Langley et al.
5,789,255 A	8/1998	Yu	2004/0171983 A1	9/2004	Sparks et al.
5,807,336 A	9/1998	Russo et al.	2005/0049179 A1	3/2005	Davidson et al.
5,820,602 A	10/1998	Kovelman et al.	2005/0065472 A1	3/2005	Cindrich et al.
5,840,020 A	11/1998	Heinonen et al.	2005/0119524 A1	6/2005	Sekine et al.
5,843,691 A	12/1998	Douglas et al.	2005/0119618 A1	6/2005	Gonelli et al.
5,846,486 A	12/1998	Pugh	2005/0171512 A1	8/2005	Flaherty et al.
5,885,245 A	3/1999	Lynch et al.	2005/0182358 A1	8/2005	Veit et al.
5,895,371 A	4/1999	Levitas et al.	2005/0197553 A1	9/2005	Cooper
5,897,493 A	4/1999	Brown	2005/0197621 A1	9/2005	Poulsen et al.
5,899,931 A	5/1999	Deschamp et al.	2006/0010098 A1	1/2006	Goodnow et al.
			2006/0074381 A1	4/2006	Malave et al.
			2006/0122577 A1	6/2006	Poulsen et al.
			2006/0189939 A1	8/2006	Gonelli et al.
			2006/0264894 A1	11/2006	Moberg et al.

2007/0016449	A1	1/2007	Cohen et al.
2007/0123819	A1	5/2007	Mernoe et al.
2007/0123829	A1	5/2007	Atterbury et al.
2007/0219496	A1	9/2007	Kamen et al.
2007/0239486	A1	10/2007	Gordon
2007/0244469	A1	10/2007	Ozeri et al.
2007/0299401	A1	12/2007	Alferness et al.
2008/0097318	A1	4/2008	Adams et al.
2008/0097324	A1	4/2008	Adams et al.
2008/0119790	A1	5/2008	Hawkins et al.

FOREIGN PATENT DOCUMENTS

EP	0320749	B1	9/1996
EP	0880936	A2	12/1998
EP	0483595	B1	12/2001
EP	1363224	A1	11/2003
EP	0949506	B1	3/2006
GB	2129203	A	5/1984
GB	2443434		5/2008
WO	WO 95/24233	A1	9/1995
WO	WO 97/00708	A1	1/1997
WO	WO 97/08605		3/1997
WO	WO 97/14104		4/1997
WO	WO 99/43283	A1	9/1999
WO	WO 00/18449	A2	4/2000
WO	WO 00/32258	A1	6/2000
WO	WO 00/45696	A1	8/2000
WO	WO 00/78210	A1	12/2000
WO	WO 01/73109	A2	10/2001
WO	WO 01/73124	A2	10/2001
WO	WO 02/06806	A2	1/2002
WO	WO 02/49507	A1	6/2002
WO	WO 02/062212	A3	8/2002
WO	WO 02/094440	A2	11/2002
WO	WO 03/005891	A1	1/2003
WO	WO 03/047426	A1	6/2003
WO	WO 2004/010231	A2	1/2004
WO	WO 2005/046559		5/2005
WO	WO 2005/093629		10/2005
WO	WO 2006/037802		4/2006
WO	WO 2007/115039		10/2007
WO	WO 2008/060827		5/2008
WO	WO 2008/106070		9/2008

OTHER PUBLICATIONS

M. Franetzki, et al., "Design and Data of a Compact Device for Sustained Program-Controlled Medicament Infusion" *Hormone and Metabolic Research, Supplement Series (1982), 12 (Islet-Pancreas-Transplant. Artif. Pancreas)*, 169-172, ISSN: 0170-5903, ISBN: 086577062x.

Lord, et al., "MiniMed Technologies Programmable Implantable Infusion System," *Annals of the New York Academy of Sciences*, 1988;531:66-71.

Prestele, et al., "A Remote-Programmable Implantable Insulin Dosing Device Part 1" *Technical Concept and Features, Hormone and Metabolic Research, Supplement Series (1982), 12 (Islet-Pancreas-Transplant. Artif. Pancreas)*, 304-7, ISSN: 0170-5903, ISBN: 086577062x.

Christopher D. Saudek, "Development of Implantable Insulin Infusion Devices", *Methods in Diabetes Research*, vol. II: Clinical Methods, 1986, pp. 347-360, Editors Clarke, William; Larner, Joseph; et al.

K. Irsigler, et al., "Long-Term Continuous Intraperitoneal Insulin Infusion with an Implanted Remote-Controlled Insulin Infusion Device," *Diabetes*, vol. 30, 1981, pp. 1072-1075.

G.A. Carlson, et al., "An Implantable, Remotely Programmable Insulin Infusion System," *Medical Progress Through Technology*, 9, 1982, pp. 17-25.

M. Franetzki, et al., "Insulin Delivery Devices: What has been Achieved, What is Feasible, and Which Medical Research is still

Needed to Specify and Optimize Future Devices?," *Artificial Systems for Insulin Delivery*, 1983, pp. 107-113.

Robert E. Fischell, "Microcomputer-Controlled Devices for Human Implantation," *Johns Hopkins API Technical Digest*, vol. 4, No. 2, 1983, pp. 96-103.

R.E. Fischell, et al., "A Programmable Implantable Medication System: Application to Diabetes," *Proceedings of the Sixteenth Annual Hawaii International Conference on System Sciences*, 1983, pp. 229-234.

Manfred Franetzki, "Drug Delivery by Program or Sensor Controlled Infusion Devices," *Pharmaceutical Research*, 1984, pp. 237-244.

Albisser, et al., "Intelligent Instrumentation in Diabetic Management," *Critical Reviews in Biomedical Engineering*, 1989, vol. 17, Issue 1, pp. 1-24.

Fabiatti, et al., "Wearable System for Acquisition, Processing and Storage of the Signal from Amperometric Glucose Sensors," *The International Journal of Artificial Organs*, vol. 14, No. 3, 1991, pp. 175-178.

Robert E. Fischell, "The Development of Implantable Medical Devices at the Applied Physics Laboratory," *Johns Hopkins APL Technical Digest*, vol. 13, No. 1, 1992, pp. 233-243.

Cress, et al., "Portable Data Acquisition and Control Apparatus for Implanted Drug Infusion Pump Interrogation," *ASAIO Journal*, 1993, pp. M695-M698.

Black, et al., "Integrated Sensor-Telemetry System for In Vivo Glucose Monitoring," *Sensors and Actuators B* 31, 1996, pp. 147-153.

Atanasov, et al., "Short-Term Canine Implantation of a Glucose Monitoring-Telemetry Device," *Med. Eng. Phys.*, vol. 18, No. 8, 1996, pp. 632-640.

Belardinelli, et al., "Advanced Technology for Personal Biomedical Signal Logging and Monitoring," *Proceedings of the 20th Annual International Conference of the IEEE Engineering in Medicine and Biology Society*, vol. 20, No. 3, 1998, pp. 1295-1298.

Beach, et al., "Subminiature Implantable Potentiostat and Modified Commercial Telemetry Device for Remote Glucose Monitoring," *IEEE Transactions on Instrumentation and Measurement*, vol. 48, No. 6, Dec. 1999, pp. 1239-1245.

Jaremko, et al., "Advances Toward the Implantable Artificial Pancreas for Treatment of Diabetes," *Diabetes Care*, vol. 21, No. 3, Mar. 1998, pp. 444-450.

Klein, et al., "A Sophisticated Programmable Minaturised Pump for Insulin Delivery," *Med. Progr. Technol.* 7, 1980, pp. 193-197.

Prestele, et al., "State of Development of Program-Controlled Implantable Insulin Delivery Systems," *Artificial Systems for Insulin Delivery*, 1983, pp. 141-153.

Prestele, et al., "Development of Program-Controlled Portable Insulin Delivery Devices," *Diabetes Care*, vol. 3, No. 2, Mar.-Apr. 1980, pp. 362-368.

Saudek, et al., "The Programmable Implantable Medication System (PIMS): Design Features and Pre-Clinical Trials," *Horm. Meta. Res.* 22, 1990, pp. 201-206.

Christopher D. Saudek, MD, "Future Developments in Insulin Delivery Systems," *Diabetes Care*, vol. 16, Supplement 3, Dec. 1993, pp. 122-132.

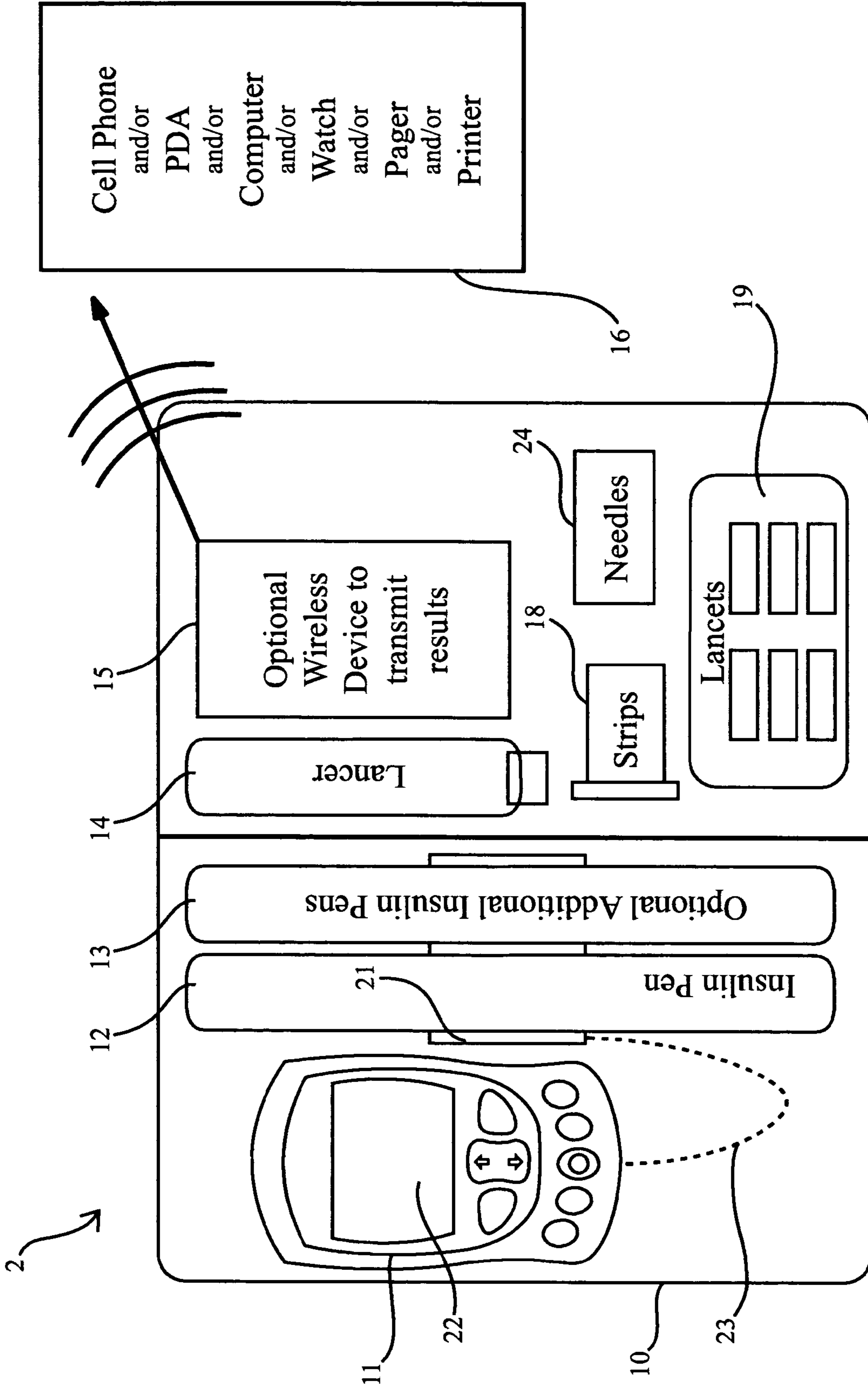
Schade, et al., "Future Therapy of the Insulin-Dependent Diabetic Patient—The Implantable Insulin Delivery System," *Diabetes Care*, vol. 4, No. 2, Mar.-Apr. 1981, pp. 319-324.

Albisser, et al., "Insulin Dosage Adjustment Using Manual Methods and Computer Algorithms: A Comparative Study," *Med. & Biol. Eng. & Comput.*, 1986, 24, pp. 577-584.

Parker, et al., "Model Predictive Control for Infusion Pump Insulin Delivery," *18th Annual International Conference of the IEEE Engineering in Medicine and Biology Society, Amsterdam*, 1996, 6.3.4: Physiological Modelling—Glucose, pp. 1822-1823.

* cited by examiner

FIG. 1



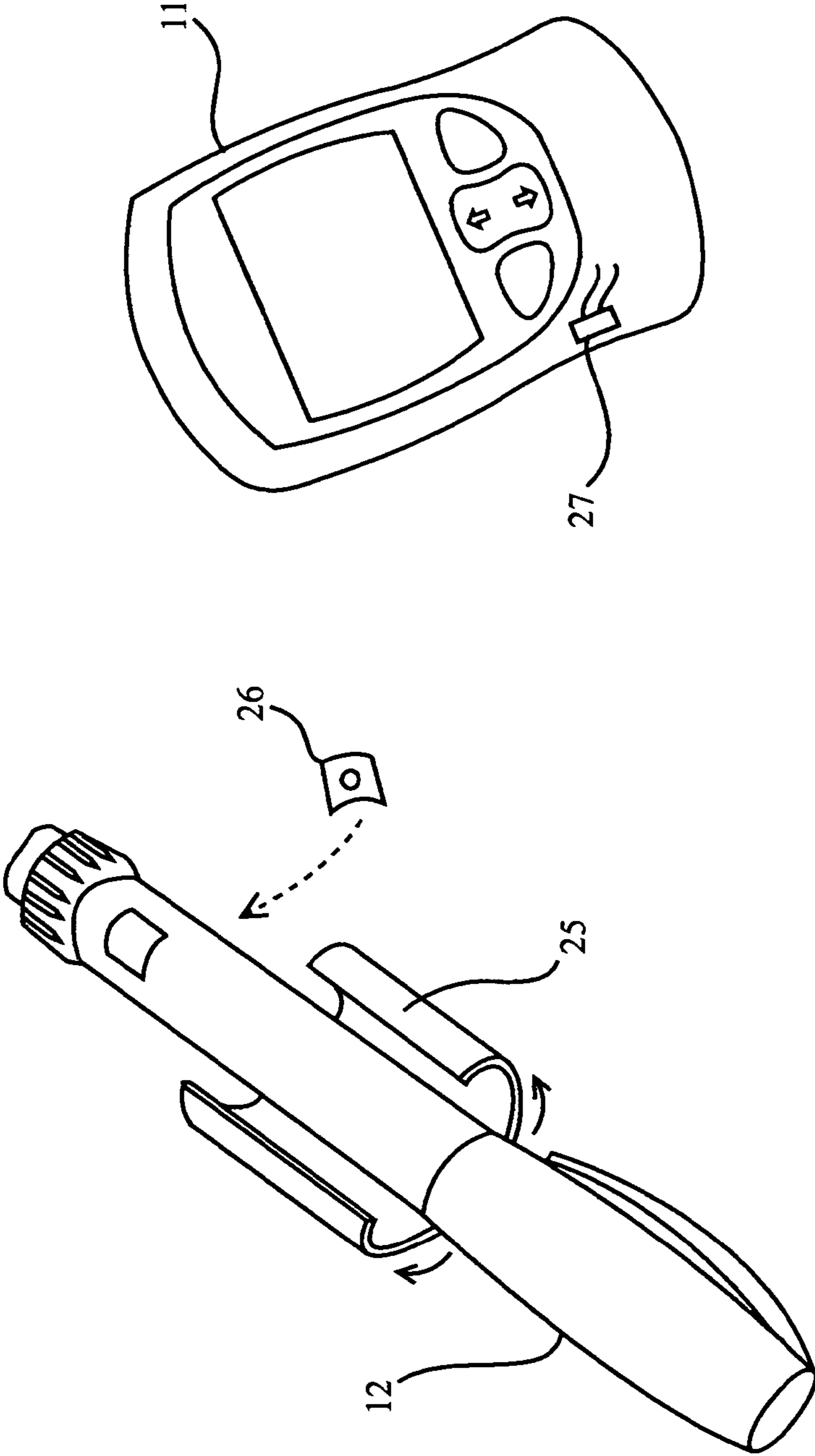


FIG. 2

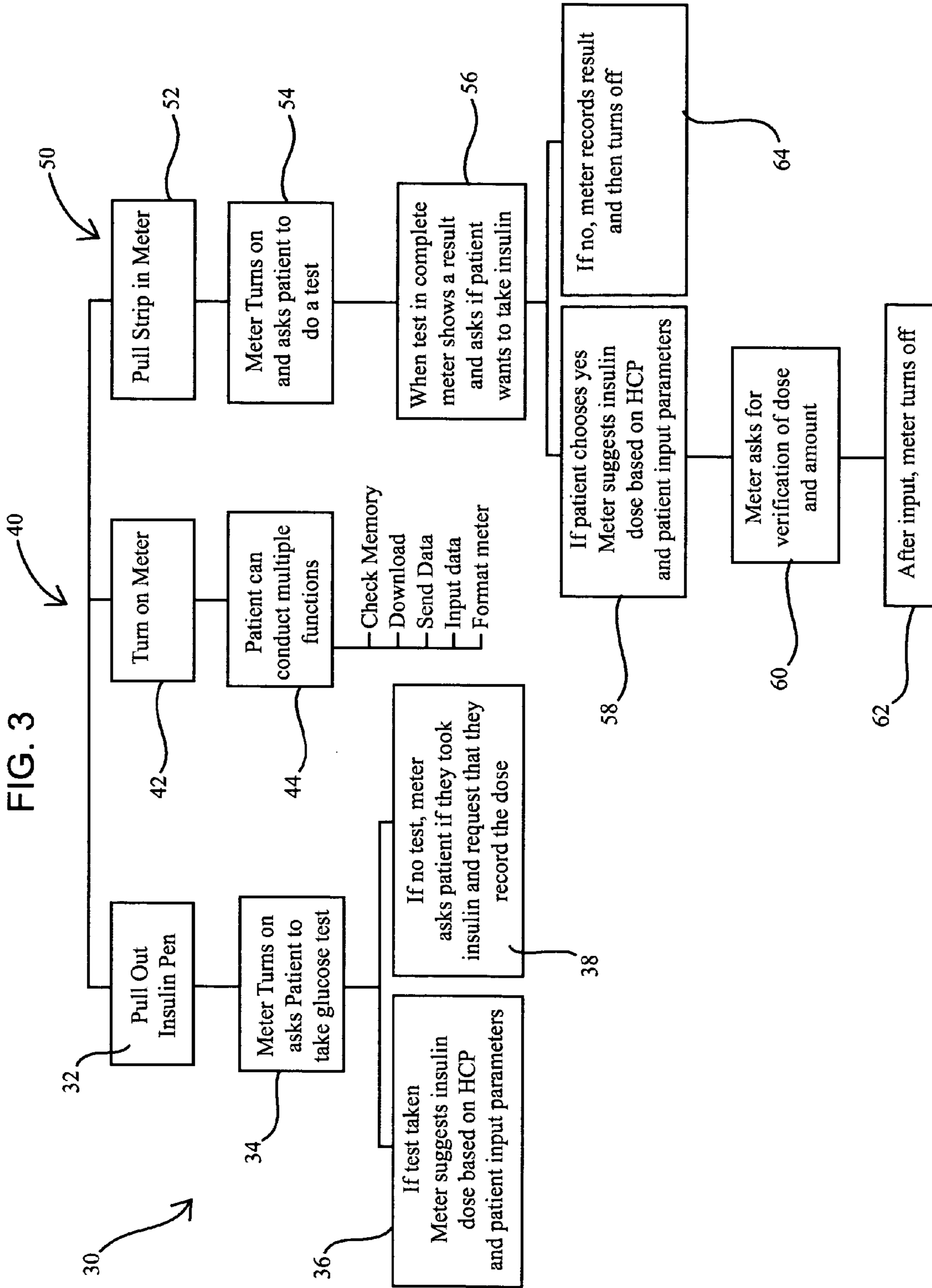
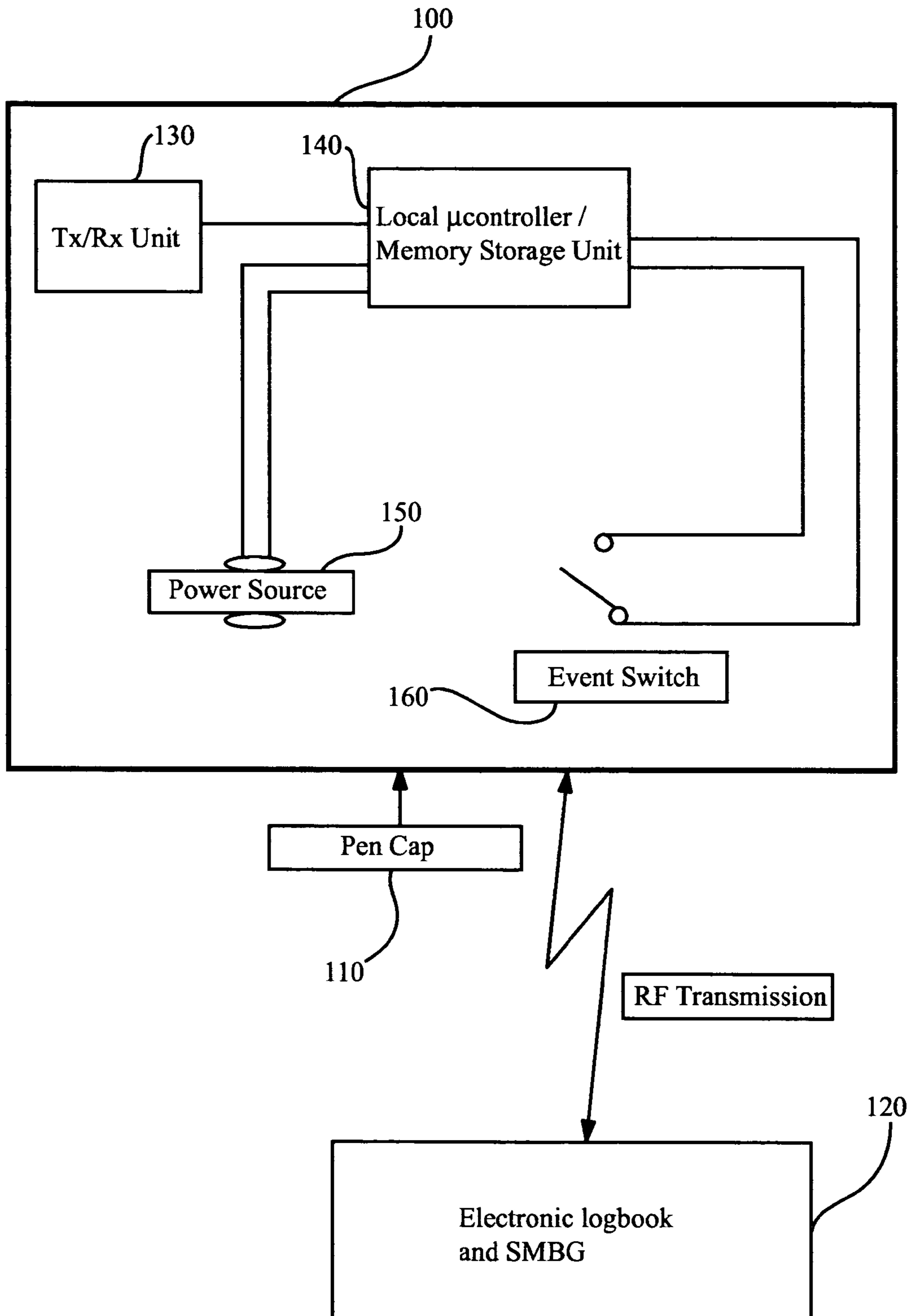


FIG. 4



**DRUG DELIVERY WITH EVENT
NOTIFICATION****CROSS-REFERENCE TO RELATED
APPLICATIONS**

This application claims the benefits under 35 U.S.C. §§120 and 121 as a Divisional application of U.S. patent application Ser. No. 12/723,505, filed Mar. 12, 2010 which is a continuation of U.S. application Ser. No. 10/981,830, now U.S. Pat. No. 7,713,229, which claims the benefit of U.S. Provisional Patent Application Ser. No. 60/518,571 filed Nov. 6, 2003, the disclosure of which is incorporated herein by reference in its entirety.

FIELD OF THE INVENTION

The present invention generally relates to a user-based drug delivery system. More particularly, the invention relates to a drug delivery system that includes a drug delivery instrument or pen provided in a container or case in which the presence or proximity of the pen to the case is detected by means configured within the case or one or more other components of the system, such as a meter, or Personal Digital Assistant (PDA) contained therein.

BACKGROUND

Medication infusion devices and physiological fluid characteristic monitoring devices are known in the medical field. One very common application of such devices is the delivery of insulin to and the monitoring of blood glucose levels of diabetics. Increased portability and ease of use of such devices have enabled the diabetic to administer a self-regulated medical treatment regime which in turn provides an increased level of patient autonomy and privacy. This is particularly beneficial since a diabetic's glucose levels may vary daily or hourly.

Such self-regulated diabetic treatment regimes often include the self-administration, either by injection and/or ingestion, of various medications, e.g., insulin. In addition to a high degree of medication compliance, for such self-regulated regimes to work effectively and safely, the patient needs to closely monitor the times at which medication is taken and may need to record or document corresponding medically relevant self-monitoring information, e.g., blood glucose level, insulin dosage, etc. The monitoring of such data helps to determine the current status and course of action (regime change) of future actions. Because the recordation or awareness of this information can be time consuming and inconvenient, particularly if done with a paper logbook, it is desirable that recordation, compilation and tracking of this type of information be as seamless and time-efficient to the user as possible.

Accordingly, there is continued interest in the development of new devices and methods for the patient-regulated monitoring and recordation of medical information, including but not limited to drug administration (injection) time and dosage, analyte concentration, e.g., glucose levels, etc. Of particular interest would be the development of a patient-controlled medication administration and monitoring system which provides the patient with flexibility and control, increases convenience, privacy and ease of use for the patient, and enhances portability of system components (e.g., glucose measurement meter, insulin injector, test strips, needles, lancets, etc.).

SUMMARY

Devices, systems and methods are provided for drug delivery and the monitoring thereof. Generally, a system of the present invention includes a drug delivery device, a holder for the drug delivery device when the device is not in use, a detector for detecting the presence of the drug delivery device within or close to the holder, and at least one algorithm for querying and prompting a user of the drug delivery device, wherein the at least one algorithm is activated upon removal of the drug delivery device from the holder. The detector may be a mechanical switch, a magnetic switch, a density switch, a capacitive switch, an electrical sensor, or an optical sensor. The holder, the detector and the at least one algorithm are incorporated into a case for housing the system. The system may further include an analyte measurement meter where the at least one algorithm is stored in the analyte measurement meter, whereby the meter is caused to turn on upon removal of the drug delivery device from the holder. In certain embodiments, the system includes means for communicating with a device for storing user information, such as drug dosing information.

A particular application of the invention is an insulin injection system which includes a meter adapted for the measurement of glucose concentration in a blood sample, an insulin injector, and a storage space for the insulin injector, the storage space including a detector adapted to activate an algorithm in the meter when the insulin injector is removed from or placed in the storage space. A case is provided which is configured for housing the meter and defining the storage space. In certain embodiments, the system includes wireless communication means for transmitting and receiving data to and from an external device, such as a cell phone, a PDA, a computer, etc.

The present invention also provides methods of monitoring the use of a drug delivery device, such as an insulin injector, where the methods generally include storing the drug delivery device when the device is not in use, removing the drug delivery device from storage, detecting the removal of the drug delivery device from storage, and activating an algorithm wherein the user of the drug delivery device is queried for information regarding use of the drug delivery device, such as drug dosage information. Other data, such as the time at which the drug delivery device is removed from storage, may be automatically recorded and stored in memory. In certain variations, the method includes transmitting the information to a data storage device.

An advantage of the present invention is the automation of the task of logging drug delivery and monitoring data, which eases the burden on the self-administering user from the effort and time of logging such information, and from remembering to do so.

These and other objects, advantages, and features of the invention will become apparent to those persons skilled in the art upon reading the details of the methods and systems of the present invention which are more fully described below.

BRIEF DESCRIPTION OF THE DRAWINGS

A better understanding of the features and advantages of the present invention will be obtained by reference to the following detailed description that sets forth illustrative embodiments, in which the principles of the invention are utilized, and the accompanying drawings of which:

FIG. 1 is a schematic illustration of an exemplary embodiment of a system according to the present invention;

3

FIG. 2 is a perspective view of another exemplary embodiment of a system according to the present invention;

FIG. 3 is a flowchart illustrating a sequence of steps in a process according to one or more exemplary embodiments of the method of the present invention; and

FIG. 4 is a schematic illustration of another exemplary embodiment of a system according to an embodiment of the present invention.

DETAILED DESCRIPTION

Before the present invention is described, it is to be understood that this invention is not limited to the particular embodiments described, as such may, of course, vary. It is also to be understood that the terminology used herein is for the purpose of describing particular embodiments only, and is not intended to be limiting, since the scope of the present invention will be limited only by the appended claims.

Where a range of values is provided, it is understood that each intervening value, to the tenth of the unit of the lower limit unless the context clearly dictates otherwise, between the upper and lower limit of that range and any other stated or intervening value in that stated range is encompassed within the invention. The upper and lower limits of these smaller ranges may independently be included in the smaller ranges is also encompassed within the invention, subject to any specifically excluded limit in the stated range. Where the stated range includes one or both of the limits, ranges excluding either or both of those included limits are also included in the invention.

Unless defined otherwise, all technical and scientific terms used herein have the same meaning as commonly understood by one of ordinary skill in the art to which this invention belongs. Although any methods and materials similar or equivalent to those described herein can also be used in the practice or testing of the present invention, the preferred methods and materials are now described.

It must be noted that as used herein and in the appended claims, the singular forms "a", "an", and "the" include plural referents unless the context clearly dictates otherwise. Thus, for example, reference to "a test strip" includes a plurality of such test strips and reference to "the device" includes reference to one or more devices and equivalents thereof known to those skilled in the art, and so forth.

The publications discussed herein are provided solely for their disclosure prior to the filing date of the present application. Nothing herein is to be construed as an admission that the present invention is not entitled to antedate such publication by virtue of prior invention. Further, the dates of publication provided might be different from the actual publication dates which may need to be independently confirmed.

While the invention is primarily described in diabetic applications, in particular in the context of insulin delivery and glucose concentration measurements, it is understood that the present invention is not so limited and may be employed in any drug delivery application, particularly where the drug delivery regime is self-administered. Other applications include, for example, the administration of human growth hormones, asthma medication, and blood thinners.

Referring now to the drawings, FIG. 1 illustrates of a schematic representation of a system 2 of the present invention which includes a storage/carry case or container 10 which provides various devices and components for use by a patient for the self-monitoring of glucose levels and the self-administration of insulin. In particular, the system includes a glucose measurement meter 11 and one or more drug delivery

4

devices 12 and 13, such as insulin injector pens or insulin syringes. Meter 11 may be any meter of the appropriate size with functionality as described herein. The delivery devices may be of the same or of a different type. One skilled in the art will recognize that any number of drug delivery devices may be included in case 10.

Case 10 may be formed from soft, pliable materials including leather, vinyl, plastic, or other suitable material known to those skilled in the art. Alternatively, case 10 may be made of a rigid material such as injection molded plastic. Closure of case 10 may be accomplished with a zipper, snap, catch, latch or any suitable securing means. Meter 11 may be secured in case 10 by a hook and loop fastener (e.g., Velcro), a loop, adhesive, or any other suitable means such that meter 11 is easily removable from case 10 by the user. Case 10 may have a configuration to attach to other modular or auxiliary cases which contain the same or similar devices and supplies. Such an auxiliary case may be helpful when traveling to ensure the availability of supplies and medication to treat oneself at any time.

Optionally, case 10 may further include compartments or containers for holding a variety of devices and components for accessing or collecting samples of blood or body fluid, such as a lancing mechanism 14, lancets 19 and needles 24. Case 10 may further include devices, such as test strips 18, for transferring and presenting the accessed or collected samples of blood or body fluid to within meter 11.

Case 10 is configured to provide communication between certain components contained within case 10. For example, case 10 may include a detection means 21 for detecting the presence or removal of drug delivery device 12 and/or 13 within or from case 10. Detection device 21 may be a switch or sensor, such as a mechanical, magnetic, density, capacitive switch, or an electrical or optical sensor, such as an infrared sensor.

Detection device 21 may be configured as shown or embedded within a cradle, cavity or holder which provides a secure means, such as a snap-fit configuration, for retaining the drug delivery devices within case 10. For example, an infrared emitter and detector may be separately mounted on opposing sides of the pen cradle. If the injector pen is present within the cradle, the infrared beam emitted by the emitter will be blocked from receipt by the infrared detector. Where the pen is absent from the cradle, the infrared beam is detected by the detector and a signal is sent to case 10 or meter 11 indicating such.

Alternatively, as illustrated in FIG. 2, the detection means may be configured for detecting the proximity of device 12 and/or 13 to case 10 or meter 11. For example, the detection means may include proximity labels 25 or 26 which may be removably affixed or adhered to drug delivery device 12 and a corresponding proximity label 27 which is provided on meter 11. The proximity labels may be in the form of a magnetic label with adhesive backing or other sensor type which may be attached to drug delivery pen 12. Meter 11 has corresponding electronics which detect the position insulin pen 12 with respect to meter 11. Therefore movement of insulin pen 12 can be detected and monitored with meter 11. For example, when the injection device is moved a specified distance, e.g., 6 inches or more, from meter 11, meter 11 would be trigger on. It is an advantage of this embodiment in that drug delivery pen 12 does not have to be attached to case 10 while at the same time the initiation of use for drug delivery pen 12 can still be monitored.

Still yet the drug delivery device detection means may include a radio frequency (RF) generating means incorporated within the drug delivery pen 10 or under a cap provided

on the pen such that, when the cap is removed from the pen, an RF signal is transmitted to case **10** or meter **11** which has an RF receiver means. This action is recorded and can be interacted (graphed) with the self-monitoring information. This embodiment reduces the active steps required to be performed by the patient, and as such, eases compliance to the prescribed treatment plan.

With any configuration of the detection means **21**, the switch or sensor may be communicatively coupled to meter **11** and/or to a microprocessor and memory chip or the like which is built in to the case itself, where meter **11** and the microprocessor/memory chip are also electrically coupled, such as by way of a serial communication port or electrical connection **23**. Alternatively, meter **11** may be integrated into case **10** where, collectively, the two form a PDA device.

Where the drug injector is preloaded with the drug to be delivered, another sensor may be employed to automatically determine the amount of drug dispensed from the injector. In this way, the patient is relieved from logging or recording this information.

Case **10** may be further equipped with a meter detector (not shown) to detect the presence and removal of meter **11** from case **10**, and as such, in order to determine whether the patient has performed a glucose measurement test prior to an insulin dosing. In this way, the appropriate prompts and queries can be made to the user. Such a meter detector may be a mechanical single pole switch mounted within the portion of case **10** in which meter **11** is retained.

Case **10** may further include a sensor (not shown) for detecting whether the case cover is open or closed. A suitable sensor may employ two flexible magnetic tape strips placed on opposite side of the case cover. When the case is closed, the system may be triggered to go into a "sleep" mode to save battery power.

Case **10** may further include means for enabling the communication between the case, meter and/or PDA and a device or system **16** external to case **10**. Examples of such external devices **16** include a cell phone, PDA, computer, watch, pager, printer, or any other device capable of receiving and/or transmitting wireless communication. To effect such, a wireless communication device **15** is integrated within the case to transmit data to and possibly receive data from these external devices **16**. Furthermore, wireless communication device **15** may be capable of exchanging data with meter **11** and/or drug delivery devices **12**, **13**. Wireless communication device **15** may transmit information through, for example, an RF signal (e.g., Bluetooth link).

In use, system **2** may be configured to operate according to any one or more of the protocols provided in the block diagram of FIG. **3**. With respect to protocol **30** of FIG. **3**, when a drug delivery device **12**, **13** is removed or is moved a specified distance (step **32**), from case **10**, the detector or sensor **21** sends or transmits a signal to meter **11** indicating that the drug delivery device has been removed and, preferably, creating a time stamp record of the event. This in turn triggers meter **11** to turn on and to display a visual (via a display **22**) and/or provide audio (via a microphone, not shown) prompt or query to the user (step **34**). For example, the user may be queried or prompted to conduct a glucose measurement test or to enter drug delivery information. If the user conducts a glucose measurement test with meter **11**, meter **11** prompts the user with a suggested dosage of insulin to be administered based on an algorithm, input from the Health Care Practitioner (HCP) and/or other parameters previously or presently entered into the meter by the user (step **36**). The user may or may not dose himself/herself with drug delivery device **12** with the suggested dosage. The user may opt to administer a

dosage other than the suggested dosage where the real-time circumstances are such that dictate such. Such a situation may arise, for example, where there is a change in the anticipated or typical intake of carbohydrates by the diabetic, e.g., during a meal, a patient finds himself eating an amount of carbohydrates greater or less than what he or she anticipated prior to the meal. At other times, the user may not elect to conduct a glucose measurement but may nonetheless administer a dosage of insulin. This is a likely scenario where the patient's blood glucose levels are fairly predictable at any given time, e.g., after a meal. If no glucose measurement test is conducted, meter **11** will query the user as to whether a dosage of insulin was administered, and if so, requests the user to enter and verify the drug dosage information (step **38**). To facilitate entry of the dosing information, the system may be configured to initially display a preset digital readout, for example, 1 unit of insulin and the user may adjust that unit value, preferably, by up-down toggle keys on meter **11** or on the PDA. Once entered, meter **11** stores the dosing data into meter's memory. The dosing data may then be automatically transmitted or prompted to be transmitted by the user to an external device **16** by wireless communication device **15**. Upon placement of drug delivery device **12**, **13** back into case **10**, meter **11** may be triggered to turn off.

As provided in protocol flowchart **40** of FIG. **3**, system **2** and meter **11** may be configured to be turned on and off by a user activated switch (step **42**) and to allow the user to conduct multiple functions (step **44**), such as check available system memory, download data, algorithms or programs, send and input data, and customize or format the meter or PDA. As provided in protocol flowchart **50**, meter **11** can also be configured to turn on by insertion of a test strip **18** into meter **11** (step **52**) which in turn triggers protocol steps (steps **54-64**) similar to those provided by protocol flow chart **30**.

FIG. **4** is a schematic representation of a glucose monitoring system of the present invention which includes an insulin pen **100**, a pen cap **110**, and a glucose meter **120**. Both insulin pen **100** and pen cap **110** have a housing which may be made of a durable IM plastic that is resistant to wear and tear as well as a variety of common household cleaning agents (bleach and alcohol) and personal use chemicals (hand moisturizers). Insulin pen **100** includes an RF transceiver unit (hereinafter referred to as RF Tx/Rx unit **130**), local microcontroller **140**, power source **150** and event switch **160**. Insulin pen cap **110** is adapted to either press fit or thread fit with insulin pen **100**. Insulin pen cap **110** is positioned such that event switch **160** is actuated when insulin pen cap **110** is removed from insulin pen **100**. Local microcontroller **140** may also include a memory element. In addition local microcontroller may control the radio, timing, power management, event storage and local electronics (i.e., event switch **160**). Event switch **160** may be a mechanical switch that closes a circuit when activated. This activation occurs when either insulin pen cap **110** is removed from insulin pen **100**. During this activation, an RF signal may be sent from insulin pen **100** to glucose meter **120**. The activation of switch **160** may be recorded and stored by local microcontroller **140**. There are numerous examples known to one skilled in the art of switches that can be activated by user actions (i.e. pressure release). Power source **150** supplies power to RF Tx/Rx unit **130**, local microcontroller **140** and event switch **160**. Power source **150** is electrically coupled to the various components via contacts that may or may not be integrated into insulin pen cap **110**.

RF Tx/Rx **130** may include transceiver, for example a Chipcon CC 1000 transceiver and a wire loop antenna which uses a frequency of 433 MHz FM band. An example of a suitable power supply **150** is a Silver Oxide RayOVac 357. A

non-limiting example of event switch **160** may be Panasonic Pushbutton switch EVQ-PAC04M.

In an alternative embodiment which reduces electronic components of insulin pen **100**, RF Tx/Rx unit **130** and local microcontroller **140** may be combined into a single package where the memory is used is an external EEPROM. Non-limiting examples which integrate RF Tx/Rx unit **130** and local microcontroller **140** include Texas Instrument Mixed Signal Processors (MSP) or Chipcon CC1010.

In another alternative embodiment which reduces power consumption by insulin pen **100**, local microcontroller **140** and power source **150** may be replaced with a radio frequency identification tag (RFID). In order to communicate with the RFID, glucose meter **120** will need a sufficiently strong RF signal generating means to power the RFID. Still yet, insulin pen cap **110** may be adapted to have an in situ power generator to replace power source **150**. When insulin cap **110** is removed from insulin pen **100**, the motion of this removal may be used to generate power for insulin pen **100**.

Glucose meter **120** may also include an electronic logbook and a RF transceiver means (similar to RF Tx/Rx unit **130**). In one an embodiment, glucose meter **120** may be similar to the commercially available LifeScan One Touch® UltraSmart® Meter. Communication between glucose meter **120** and insulin pen **100** is accomplished via an RF protocol. Glucose meter **120** acts as the “master” and the electronic elements within insulin pen **100** act as a “slave”. Glucose meter **120** periodically prompts insulin pen **100** to determine whether an event, e.g., removal of the pen from the case or removal of the cap from the pen, has been recorded. If an event has been recorded by the slave, a message will be sent to glucose meter **120** indicating an event has occurred as—as well as the time of the event. Glucose meter **120** will record the event and may query the patient for further information and supply a notification.

In an embodiment of this invention, a user may remove insulin pen cap **110** from insulin pen **100**. In doing so, a RF signal is sent from insulin pen **100** to glucose meter **120** indicating that the user is about to initiate an insulin injection. Glucose meter **120** may then indicate to the user on a LCD screen their most recent pre-prandial and post-prandial glucose level. Glucose meter **120** may prompt the user to insure that these values are correct and if not, glucose meter **120** may allow the user to adjust these values accordingly. In an embodiment of this invention, glucose meter **120** may perform a bolus calculation algorithm where a recommended level of insulin to be injected with insulin pen **100** is shown on the LCD of glucose meter **120**. Depending on the situation, the user may inject the recommended insulin dose or inject a different amount. Glucose meter **120** may prompt the user to input the actual dose of insulin allowing for an inventory of insulin remaining in insulin pen **100** to be accessed. When insulin pen **100** is low in insulin (i.e., 10% remaining), glucose meter **120** may prompt the user to procure an additional insulin pen as needed. In another embodiment of this invention, glucose meter **120** may prompt the user to input other types of information after activating event switch **160** such as breakfast, lunch, dinner, snack, alcohol, carbohydrates, fats, calories, proteins, medication, pills, insulin, pump bolus, health notes, ketones, HBAIC, microalbumin, cholesterol, blood pressure, and exercise.

It is an advantage of this invention in that the user does not have to manually record the time at which insulin is injected with insulin pen **100**. This simplifies the ability of the user to gather data more effectively to manage their disease. It is a further advantage of this invention in that actuating switch **160** sends a wireless signal to glucose meter **120** prompting

the user to perform one several steps that facilitate compliance with the user in regards to their diabetic therapies. Glucose meter **120** may seamlessly display the most recent and relevant glucose concentrations, prompt user for more updated glucose concentrations, recommend an insulin dosage based on recent glucose measurements, or prompt user to input other relevant data.

In an alternative embodiment to this invention, insulin pen **100** may be replaced with a “pill bottle” that contains medication (medication example—Glucotrol XL®). In such an embodiment, the “pill bottle” will include Tx/Rx unit **130**, local microcontroller **140**, power source **150**, and event switch **160**. In addition, insulin pen cap **110** must then be replaced with a pill bottle cap.

Also provided by the subject invention are kits for use in practicing the subject methods. The kits may further include software programs recorded on a CD-ROM or the like, which programs may be downloaded to the meter, PDA and/or an external data device for use with the systems. Finally, the kits may further include instructions for using the subject devices and systems. These instructions may be present on one or more of the packaging, label inserts or containers within the kits, or may be provided on a CD-ROM or the like.

The preceding merely illustrates the principles of the invention. It will be appreciated that those skilled in the art will be able to devise various arrangements which, although not explicitly described or shown herein, embody the principles of the invention and are included within its spirit and scope. Furthermore, all examples and conditional language recited herein are principally intended to aid the reader in understanding the principles of the invention and the concepts contributed by the inventors to furthering the art, and are to be construed as being without limitation to such specifically recited examples and conditions. Moreover, all statements herein reciting principles, aspects, and embodiments of the invention as well as specific examples thereof, are intended to encompass both structural and functional equivalents thereof. Additionally, it is intended that such equivalents include both currently known equivalents and equivalents developed in the future, i.e., any elements developed that perform the same function, regardless of structure. The scope of the present invention, therefore, is not intended to be limited to the exemplary embodiments shown and described herein. Rather, the scope and spirit of present invention is embodied by the appended claims.

What is claimed is:

1. A drug delivery system comprising:

a microprocessor device; and

a drug delivery device separate from the microprocessor device and configured to deliver drug to a user, the drug delivery device including:

a microcontroller connected to a memory unit;

a wireless transmitter connected to the microcontroller so that data is transmitted from the microcontroller to the microprocessor device; and

an event switch connected to the microcontroller so that upon activation of the switch, the microcontroller communicates with the microprocessor to cause the microprocessor device to indicate the user’s most recent blood glucose measurement, provide a suggestion for dosage of the drug based on the user’s entered input parameters, and recommendation from a health care provider previously stored or entered into a memory of the microprocessor device.

2. The drug delivery system of claim 1, further comprising a display screen configured to display the user’s most recent blood glucose measurement.

3. The drug delivery system of claim 2, in which the most recent blood glucose measurement comprises one of a most recent pre-prandial and post-prandial blood glucose level.

4. The drug delivery system of claim 1, in which the microcontroller is configured to record a date and time of activation of the event switch.

5. The drug delivery system of claim 1, in which the microprocessor device is configured to prompt the user to input other types of information after activation of the event switch.

6. The drug delivery system of claim 5, in which the other types of information comprises breakfast, lunch, dinner, snack, alcohol, carbohydrates, fats, calories, proteins, medication, pills, insulin, pump bolus, health notes, ketones, HbA1c, Microalbumin, cholesterol, blood pressure, or exercise.

7. The drug delivery system of claim 1, in which the event switch

comprises a switch selected from the group consisting essentially of a mechanical switch, a magnetic switch, a density switch, a capacitive switch, an electrical sensor, an optical sensor or combinations thereof.

8. The drug delivery system of claim 1, in which the drug delivery device comprises an insulin pen.

9. The drug delivery system of claim 1, in which the microprocessor device comprises a device selected from a group consisting of a cell phone, personal-data assistant, computer, watch, or pager.

10. The drug delivery device of claim 1, in which the microprocessor device comprises a cellular phone.

11. A drug delivery system comprising:

a drug injector preloaded with a drug to be delivered with a sensor to automatically determine an amount of drug dispensed from the injector to relieve a user from logging or recording the amount of drug dispensed;

a blood glucose meter configured to provide a prompt to the user with a suggested dosage based on an algorithm, input from a health care practitioner and other parameters previously entered by the user, upon a blood glucose measurement test by the user; and

a case to store the blood glucose meter, the case being equipped with a detector to detect the presence and removal of the meter from the case so as to determine whether the user has performed a glucose measurement test prior to dosing with the drug injector.

12. A drug delivery system comprising:

a drug injector preloaded with a drug to be delivered with a sensor to automatically determine an amount of drug dispensed from the injector to relieve a user from logging or recording the amount of drug dispensed;

a blood glucose meter configured to provide a prompt to the user with a suggested dosage based on an algorithm, input from a health care practitioner and other parameters previously entered by the user; and

an event switch in communication with the meter so that upon activation of the switch, the meter indicates the user's most recent blood glucose measurement and provides a suggestion for dosage of the drug based on the user's entered input parameters and recommendation from a health care provider previously stored or entered into a memory of the meter.

13. The drug delivery system of any one of claims 11 and 12, the meter further comprising a display screen configured to display the user's most recent blood glucose measurement.

14. The drug delivery system of claim 13, in which the most recent blood glucose measurement comprises one of a most recent pre-prandial and post-prandial blood glucose level.

15. The drug delivery device of claim 11, in which the meter is configured to prompt the user to input other types of information after activation of the detector.

16. The drug delivery system of claim 12, in which the meter is configured to prompt the user to input other types of information after activation of the event switch.

17. The drug delivery system of any one of claims 16 and 15, in which the other types of information comprises breakfast, lunch, dinner, snack, alcohol, carbohydrates, fats, calories, proteins, medication, pills, insulin, pump bolus, health notes, ketones, HbA1c, Microalbumin, cholesterol, blood pressure, or exercise.

18. The drug delivery system of claim 11, in which the detector comprises a switch selected from the group consisting essentially of a mechanical switch, a magnetic switch, a density switch, a capacitive switch, an electrical sensor, an optical sensor or combinations thereof.

19. The drug delivery system of claim 12, in which the event switch comprises a switch selected from the group consisting essentially of a mechanical switch, a magnetic switch, a density switch, a capacitive switch, an electrical sensor, an optical sensor or combinations thereof.

20. The drug delivery system of any one of claims 11 and 12, in which the drug injector comprises an insulin pen.

21. The drug delivery system of any one of claims 11 and 12, in which the meter is configured to request the user to enter and verify the drug dosage information for storage by the meter.

22. The drug delivery system of claim 21, further comprising a wireless communication device in communication with the meter and configured to automatically transmit dosage amount stored on the meter to an external device.

23. The drug delivery system of claim 22, in which the external device comprises at least one of a cell phone, PDA, computer, watch, pager, printer, or any other device capable of receiving and/or transmitting wireless communication.

24. The drug delivery system of claim 12, in which the microcontroller is configured to record a date and time of activation of the event switch.

* * * * *